WIND TURBINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to wind turbine apparatus, and more specifically to a wind turbine rotor assembly of low weight and compact character, a turbine mounting system of low weight and flexible character with respect to its ability to translate in response to changes in wind direction, and a pivoting support tower.

2. Description of the Prior Art

A variety of wind turbine systems have been proposed and/or employed in the art.

These systems, while representing a wide variety of shapes, structures, and features, are generally classifiable by wind turbine axis direction, yaw character (free yaw, damped, or driven yaw), and wind turbine blade pitch (fixed pitch or variable pitch).

Horizontal axis wind turbines are characterized by an axis of rotation which is parallel to the ground. Vertical axis wind turbines are characterized by an axis of rotation which is perpendicular to the ground. Horizontal axis wind turbines may deploy the rotor either upwind or downwind of the associated supporting tower. Horizontal axis wind turbines typically feature one of three design modalities to adjust the position of the rotor to the changing direction of the wind. Free yaw wind turbines rotate freely on the supporting tower in response to wind direction, driven yaw wind turbines incorporate motors to rotate the turbine in response to changes in wind direction, so that the turbine actively tracks the changing direction of the wind. Damped yaw wind turbines include damping device(s) which decelerate the otherwise uncontrolled rotation of the turbine as the wind changes.

Variable pitch wind turbines include mechanisms for the adjustment of the pitch of the rotor blades with relation to the wind direction for maximum efficiency at a variety of wind speeds. Fixed pitch wind turbines feature stationary rotor blades which have a constant pitch in relation to the wind direction.

Wind turbine apparatuses also differ in rotor diameter and rated power output. Single generator and multiple generator configurations are known, and a wide range of power outputs are obtainable from wind turbine apparatuses which have been commercialized to date.

Wind turbine apparatuses may be mounted for operation on a wide variety of supports and towers, including self-supporting tubular towers, self-supporting lattice towers, or guyed tubular towers.

In addition to the above-described variant types of wind turbines, such turbines may feature a wide variety of ancillary structural and operation features. For example, a nacelle may be incorporated surrounding the rotor. Blade tip brakes may be incorporated to prevent damage caused by excessive rotational speeds at high wind velocities.

Examples of wind turbine apparatus which are commercially available and/o in actual use include wind turbine apparatus of the following manufacturers: Holec/Polenko, (Netherlands) (upwind, fixed pitch, dual yaw rotors, self-supporting tubular tower); Holec/-Windmatic (Denmark) (upwind, fixed pitch, dual yaw rotors, self-supporting lattice tower); Howden Windparks, Inc. (Scotland) (upwind, steel tubular tower with conical base); Micon (Denmark) (upwind, fixed pitch, self-supporting steel tubular tower with inside ladder to nacelle); Nordtank (Denmark) (upwind, fixed pitch, steel tubular tower); Vestas (Denmark) (upwind, lattice tower); HMZ-Windmaster (Belgium) (upwind, hydraulically pitched blades, tubular tower with inside ladder to nacelle); Dangren Vind Kraft/Bonus (Denmark) (upwind, fixed pitch, self-supporting steel tubular tower); FloWind Corp. (vertical axis); Enertech (downwind, free yaw, blade tip brakes, self-supporting tower); Fayette Manufacturing Corp. (downwind, blade tip brakes, guyed pipe tower); U.S. Windpower, Inc. (downwind, free yaw, variable pitch blades, remote computer control tripod tower); Danish Wind Technology (Denmark) (downwind, free yaw with hydraulic damping, variable pitch, computer control, steel tubular tower with inside ladder to nacelle); Energy Sciences, Inc. (downwind, blade tip brakes, free yaw, tilt-down lattice tower); Wind Power Systems (downwind, tilt- C down lattice tower, no nacelle); Danwin (Denmark) (upwind, tubular tower); BSW/Wagner (Germany) (upwind, fixed pitch, driven yaw, lattice tower); Alternegy/Aerotech (Denmark) (upwind, tubular tower with inside ladder to nacelle); W.E.G. (England) (upwind, tubular tower, variable pitch); and Windworld (Denmark) (upwind, fixed pitch, tubular tower).

Despite the wide variety of wind turbine systems which have evolved in the art to date, as exemplified by the above-discussed designs, there is a continuing need for an improved wind turbine apparatus of low weight and compact character, which is structurally and operationally adapted to perform in a wide variety of wind conditions, without adverse affect on the structural integrity and operability of the wind turbine system. Even in areas where the average wind speed is relatively constant on a seasonal or even annual basis, there nonetheless exist substantial variations in wind direction and intensity.

Such shifting wind conditions even in computer-controlled yaw-driven turbine systems, entail substantial "shock" forces—tensional, compressive, and torsional forces—on the rotor blades, carbon body and internal components, as well as the tower. Such shock forces, if not satisfactorily damped or otherwise attenuated, can severely shorten the operating life of the turbine assembly, and occasion damage to the turbine blades and components, thereby rendering the turbine apparatus deficient or even useless for its intended purpose.

In addition, the art is continually seeking reduced weight and more compact wind turbine structures, to render wind turbine systems more economic in character and competitive as alternative energy systems relative to conventional coal-fired generating plants, nuclear power facilities, and hydroelectric systems.

Accordingly it is an object of the present invention to provide an improved wind turbine assembly of low weight and compact character.

It is another object of the present invention to provide a wind turbine assembly which is of low weight and flexible character with respect to the ability of the wind turbine to translate in response to changes in wind direction.

It is a still further object of the present invention to provide an improved wind turbine assembly which features adjustable pitch rotor blades which are associated with independent suspension means, whereby mechanical and hydraulic shocks resulting from changes in wind direction and intensity are efficiently damped to